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CONTAINMENT SEALERS (U) ORNL ENGINEER MATERIALS EXPERIMENT

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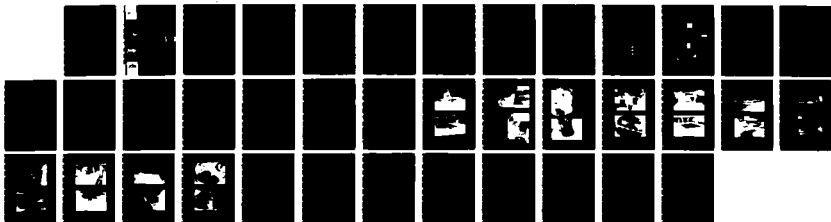
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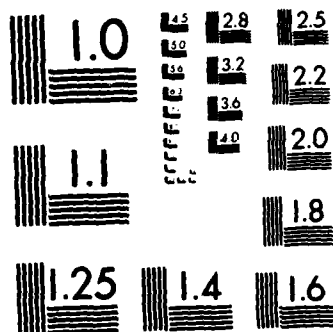
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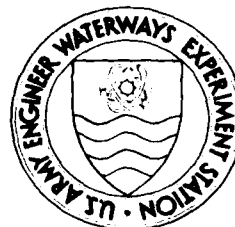
FACILITIES TECHNOLOGY APPLICATION TESTS; FUEL-RESISTANT PAVEMENT SEALERS

by

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<p>➤ This report details equipment, personnel, and material requirements as well as procedures used to demonstrate the application of fuel-resistant pavement sealers to asphaltic concrete airfield pavements.</p> <p>The demonstrations took place at Ft. Rucker and Ft. Belvoir. These locations each have asphalt pavements which are continually damaged by fuel spillage. Five sealers were placed at each location.</p>					
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PREFACE

This project was sponsored by the Office, Chief of Engineers (OCE), US Army, as a part of the O&MA Program, Facilities Technology Application Tests (FTAT) Demonstration Program, FY 84.

The project was conducted under the general supervision of Dr. W. F. Marcuson III, Chief, Geotechnical Laboratory (GL), US Army Engineer Waterways Experiment Station (WES), and under the direct supervision of Mr. H. H. Ulery, Jr., Chief, Pavement Systems Division (PSD), GL; Mr. J. W. Hall, Jr., Chief, Engineering Investigations, Testing, and Validation Group, PSD; and Dr. E. R. Brown, Chief, Material Research Center, PSD. WES FTAT Project Manager was MAJ R. A. Hass. This report was prepared by Mr. James E. Shoenberger, GL.

Mr. Robert A. Baylot, Jr., of the WES Information Products Division, Information Technology Laboratory (ITL), edited this report. Ms. Loriece M. Beall of ITL designed and composed the layout.

Personnel who participated in the final inspection of the fuel-resistant sealer sections included Mr. Art Vance, Department of Defense; Mr. Mike Jones, US Navy; Mr. Robert Williams, OCE; Mr. Cary Williams, US Army Training and Doctrine Command; and Dr. Elton R. Brown, WES. Mr. A. F. Shook of ARE, Inc., also made an independent inspection of the sealers at Ft. Belvoir, Va.

COL Allen F. Grum, USA, was the previous Director of WES. COL Dwayne G. Lee, CE, is the present Commander and Director. Technical Director is Dr. Robert W. Whalin.



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CONTENTS

	Page
PREFACE	1
CONVERSION FACTORS NON-SI TO SI (METRIC) UNITS OF MEASUREMENT	3
PART I: INTRODUCTION	4
PART II: DEMONSTRATION	5
Site Selection	5
Coordination	5
Logistics	5
Construction Procedure, Ft. Rucker	5
Construction Procedure, Ft. Belvoir	8
Construction Recommendations and Observations from Demonstrations	8
PART III: PROJECT PROCEDURES	10
Equipment Required	10
Personnel Required	10
Materials Required	10
Recommended Construction Method	10
Application Rates	11
PART IV: ECONOMICS	12
PART V: ADVANTAGES/DISADVANTAGES	13
PART VI: SUMMARY	14
TABLES 1-4	
PHOTOS 1-22	
APPENDIX A: FACT SHEETS	A1
APPENDIX B: INSPECTION OF FUEL-RESISTANT SEALERS AT FT. RUCKER, ALA., AND FT. BELVOIR, VA.	B1

CONVERSION FACTORS, NON-SI TO SI (METRIC) UNITS OF MEASUREMENT

Non-SI units of measurement used in this report can be converted to SI (metric) units as follows:

<i>Multiply</i>	<i>By</i>	<i>To Obtain</i>
feet	0.3048	metres
gallons per square yard	4.5273	cubic decimetres per square metre
gallons (US liquid)	3.785412	cubic decimetres
inches	2.54	centimetres
pints (US liquid)	0.4731765	cubic decimetres
pounds (mass)	0.4535924	kilograms
pounds (mass) per square yard	0.542492	kilograms per square metre
quarts (US liquid)	0.9463529	cubic decimetres
square feet	0.09290304	square metres
square yards	0.8361274	square metres

Facilities Technology Application Tests; Fuel-Resistant Pavement Sealers

PART I: INTRODUCTION

1. Each year significant damage occurs to asphalt pavements due to the spillage of fuel, oil, and hydraulic fluids. The asphalt binder in the pavement is softened by these fluids causing the asphalt pavement to become unstable under traffic. To prevent or minimize damage caused by this spillage, a fuel-resistant seal coat, usually a tar base material, must be applied to protect the asphalt pavement. These seal coats have performed with limited success because they have been susceptible to cracking and raveling resulting in failure of the seal coat.

2. A number of sealers on the market are being promoted as fuel resistant, but most of these sealers lack documented information concerning their field performance.

3. In 1980 the US Air Force Engineering and Services Center at Tyndall Air Force Base funded a study of fuel-resistant sealers and binders for porous friction surfaces (PFS).^{*} From this study the US Army Engineer Waterways Experiment Station (WES) developed a laboratory test method to evaluate the effectiveness of products to

resist damage from fuel spills. The results of these tests enabled the various products to be ranked according to their fuel resistance.

4. In 1981 WES was requested to develop a fuel-resistant sealer material specification using the information gained from the previous PFS study. A report was written along with the specification describing the products tested and the procedures developed for the specification.^{**}

5. The results from the above studies were used to select the five fuel-resistant sealers to be applied in these demonstrations. Table 1 lists the sealers used.

6. Fuel spills normally occur during aircraft operations from leaking fuel lines or tanks and also during engine shutdowns. During engine shutdown the fuel remaining in the engine will be dumped onto the pavement (usually 1 to 2 pt† of fuel). These spills have an accumulative detrimental effect on asphalt concrete pavements, resulting in erosion of the asphalt and fine aggregate from the surface.

^{*} James E. Shoenberger. 1983. "Fuel-Resistant Coatings and Binders for Porous Friction Surface Pavements: Tests and Analysis," ESL-TR-83-33, Air Force Engineering and Services Center, Tyndall, Air Force Base, Fla.

^{**} James E. Shoenberger. 1984. "Fuel-Resistant Pavement Sealers," Miscellaneous Paper GL-84-11, US Army Engineer Waterways Experiment Station, Vicksburg, Miss.

† A table of factors for converting non-SI to SI (metric) units of measurement is presented on page 3.

PART II: DEMONSTRATION

Site Selection

7. Ft. Rucker, Ala., and Ft. Belvoir, Va., were the demonstration sites selected for application of fuel-resistant pavement sealers (Figures 1 and 2). These locations regularly receive aircraft traffic that expose their asphalt parking aprons to fuel spillage.

Coordination

8. The following are addresses of personnel who supplied assistance in completing the demonstration projects at their respective locations:

Director
Directorate of Engineering and Housing
ATTN: Mr. Barney O'Field, Bldg 1405
Ft. Rucker, AL 36362

Commander
US Army Center, Ft. Belvoir
Directorate of Engineering and Housing
ATTN: Mr. Dean Smith
Ft. Belvoir, VA 22060

Logistics

9. The sealer materials were purchased and shipped to WES before the start of work. The sealer materials, along with required mixing and placement tools, were transported by truck from WES to the jobsite. Photographers, technicians, and laborers were provided by WES for each demonstration. A point of contact at each base informed interested individuals of the date, time, and location of each demonstration. Ft. Rucker provided several laborers to

assist in the demonstration. Handouts, describing the demonstration materials and techniques, were available for interested observers.

Construction Procedure, Ft. Rucker

Preparation

10. The asphalt concrete pavements which were sealed were located adjacent to portland cement concrete helicopter landing pads (Photo 1). The asphalt concrete pavement was in reasonably good condition and received no special preparation prior to sealing other than sweeping and cleaning with compressed air (Photo 2). The asphalt pavement adjacent to several of the concrete pads had some localized damage where fuel had flowed off the pads and onto the pavement during normal aircraft operations (Photo 3).

Mixing

11. The sealers were premixed in their own containers to help assure a uniform consistency (Photo 4). The sealers were then combined and/or thinned in accordance with manufacturers' recommendations and mixed in plastic garbage cans (Photo 5) (see Appendix A). Concrete sand was added to the mix to provide a satisfactory skid-resistant surface for traffic (Photo 6). The amount of sand added varied with the type of sealer and ranged from approximately 0.6 to 2.2 lb per gal of sealer (Table 2). Eight-quart galvanized steel buckets were used to measure and transport the various materials and sand (Photo 7). A 1/2-in. electric drill with metal stirrers was used for mixing and stirring all materials (Photo 8).

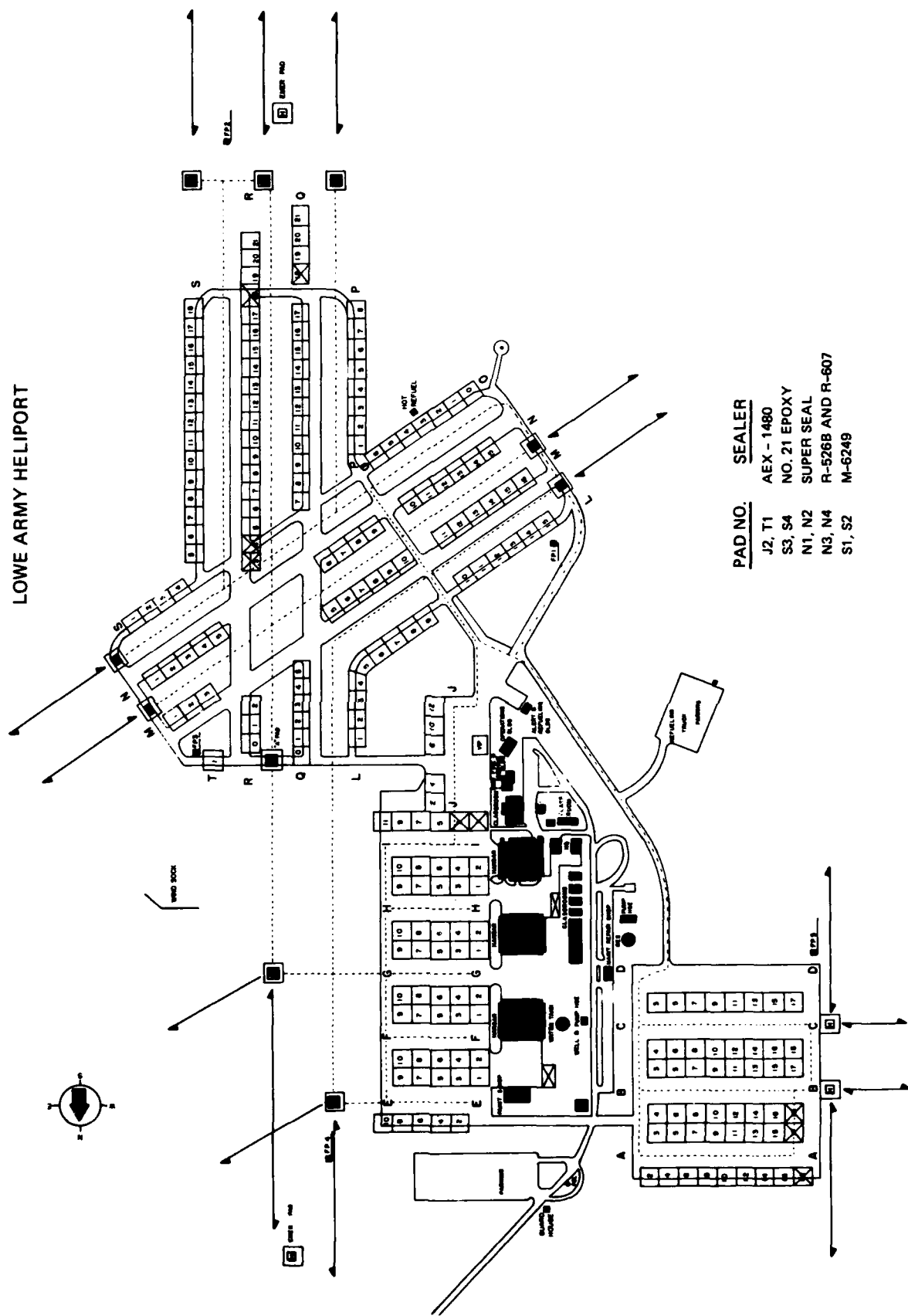


Figure 1. Fuel-resistant sealer demonstration site at Ft. Rucker

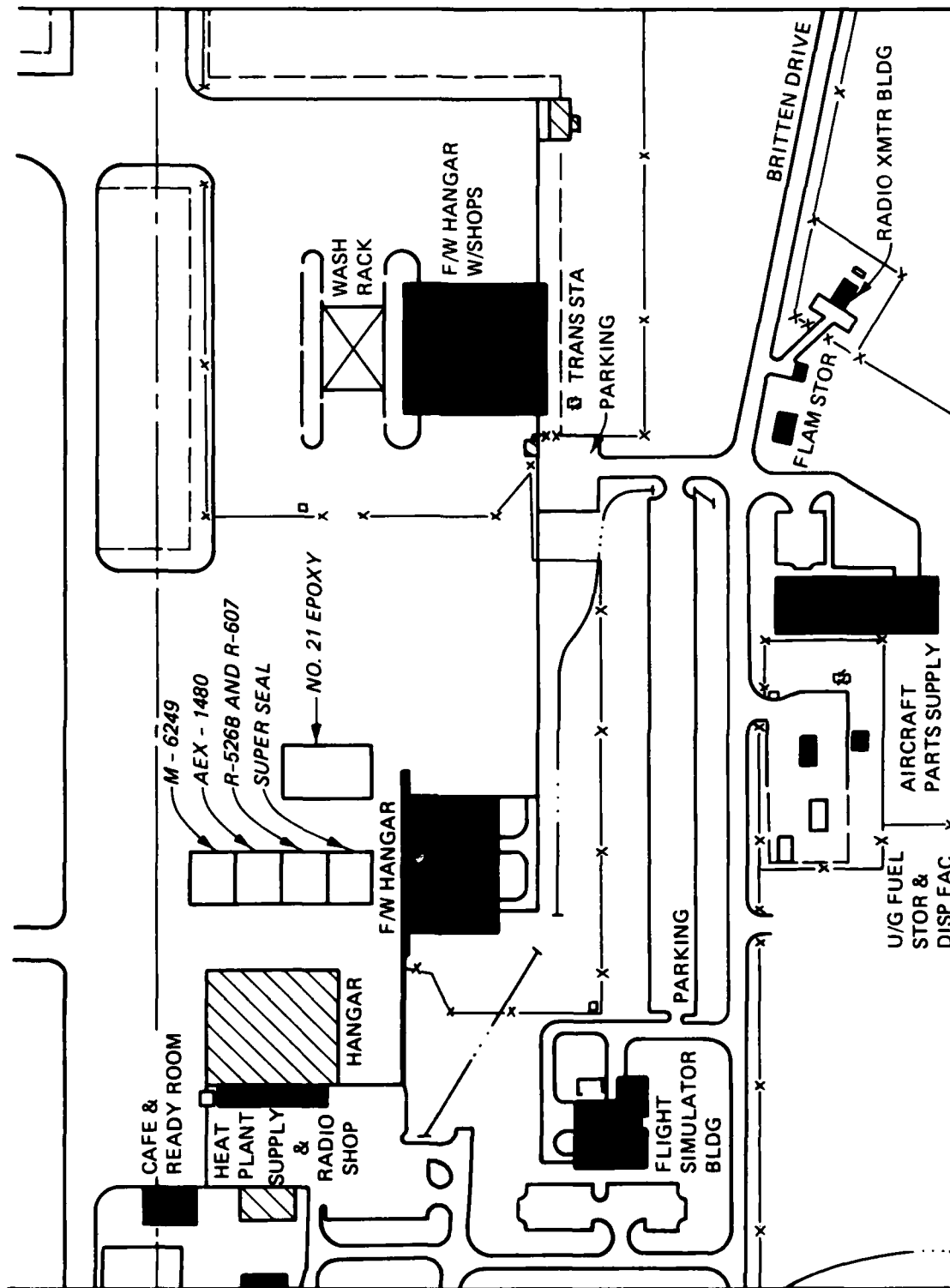


Figure 2. Davison Army Airfield fuel-resistant sealer demonstration site

Application

12. The sealer mixture was poured on the asphalt pavement and squeegees were used to spread the material (Photo 9). Two types of squeegees were used—stiff wooden-supported rubber and more flexible metal-supported rubber squeegees. Two coatings of each sealer were applied to each area on successive days (Table 2).

Conduct of demonstration

13. The Ft. Rucker demonstration was conducted from 26-27 May 1984. Ten sites (landing pads) were selected for the demonstration at Lowe US Army Heliport. The first day each pad received a coating of one of the sealers followed by another coating of the same material the next day. The weather was warm and sunny during the entire demonstration period. The concrete pads measured 13 by 15 ft and the sealer application extended outward approximately 15 ft in all directions from the edge of the concrete. This resulted in a sealed area of approximately 140 sq yd around each pad (Photo 10).

Construction Procedures, Ft. Belvoir

Preparation

14. The pavements sealed were parking aprons used primarily by C-12 airplanes (Photo 11). Six parking areas were selected for sealing; two of these were satisfactory for sealing without repairs. The remaining four parking areas damaged by previous fuel spillage were repaired shortly before application of the fuel-resistant sealers (Photos 12-14). Scheduling difficulties prevented allowing the recommended cure time of the asphalt patches before sealing. The areas were sealed one day after they were patched.

Mixing

15. Mixing of the sealers was performed in the same manner as described for Ft. Rucker (see Appendix A). The main difference was that the four materials that were applied in two coatings had sand added to the top coat only. Table 3 gives the amounts of sand and sealer applied to each coating.

Application

16. The application procedures were generally the same as those described for Ft. Rucker. The only addition was the use of two wire bristle squeegees supplied by one of the manufacturers to help apply the sealers (Photo 15).

Conduct of demonstration

17. The Ft. Belvoir demonstration was conducted from 27-30 June 1984 at Davison US Army Airfield. Two parking areas with limited minor distress from previous fuel spillage (Photo 16) were sealed with No. 21 Epoxy. The sealer was applied to these areas in a single coating (Photo 17). The manufacturer's representative advised that a single coating was satisfactory to obtain a complete seal. The remaining four products were placed in two coatings on four repaired parking areas. The individual parking areas which were sealed measured approximately 60 by 50 ft.

18. The sealers were placed on dry pavement during generally overcast conditions and in between rain showers. Photos 18 and 19 show the parking areas after sealing.

Construction Recommendations and Observations from Demonstrations

Equipment

19. A 1/2-in. power drill with two commercially available mixing attachments

was used to mix the sealers and sand for application. One of the two mixing attachments (see mixing blade attached to drill in Photo 8) was designed not to splash, an important feature during mixing operations. Wooden paddles were used to mix materials that required mixing to the bottom of the barrels. The use of wooden paddles would also be advantageous when there is no electricity available (see Photo 4). A small portable generator was used to provide electrical power for the two demonstration projects. Several 10-qt galvanized buckets were used for measuring the sealers and sand and to handle the mixture. Three types of squeegees were used in the demonstrations. Two of them were rubber tipped—one with wooden support and one with metal support (Photo 20). The wooden-supported squeegees were stiffer, mainly because there was less unsupported rubber. The last type was a metal wire bristle squeegee (Photo 15). A 32-gal capacity plastic garbage can was used for mixing. Any similarly sized container will work for mixing, and one that has handles will assist in any transport.

Mixing

20. Sealer components and, if necessary, thinners should be added and mixed before the addition of sand. The amount of sealer material mixed at one time was limited mainly by the amount that could be conveniently conveyed to the mixing can. The sand can be added while the mixer is

running; this helps achieve better coating and faster mixing (Photo 21). Super Seal and AEX-1480 are capable of being mixed with sand containing some moisture. The remaining sealers required dry sand for proper mixing and coating.

Application

21. Sealers with a low viscosity must be placed immediately after mixing since the sand will not remain in suspension for very long. Using smaller batches of sealer and pouring the sealer mixture where it is to be placed will help provide for uniform placement of the sand with the sealer. The type of squeegee required for best results will depend on the type of sealer used. Sealers with low viscosity that do not hold sand in suspension for long, require stiffer rubber squeegees (wooden-supported) to assist in spreading the sand and sealer mixture. The flexible rubber squeegees (metal-supported) worked well at achieving an even spread over surface irregularities (cracks and depressions) and also left a smooth, even surface. The other type of squeegee used, one with wire bristles, worked moderately well at both spreading sand and obtaining good coverage. It also left a slightly rougher or coarser surface texture. With any type of squeegee used, the best workmanship is obtained by working the sealer from side to side while advancing the sealer forward (Photo 22).

PART III: PROJECT PROCEDURES

Equipment Required

22. The type of equipment used depends on the amount and type of sealer to be placed and the area to be sealed. Small amounts can be adequately placed by hand with squeegees and portable mechanical mixers. A small portable generator can be used to provide electricity. Larger amounts require placement by suitable self-propelled mechanical-type distributors capable of accurately metering and mixing the slurry components and placing the mixture all in one operation.

Personnel Required

23. Properly trained personnel are required to assure proper mix proportions and application of fuel-resistant pavement sealers. These skills are easily developed, and one or two of these trained personnel could supervise untrained personnel to mix and apply the sealers. Mechanical application would require from two to four people for normal operations. Hand application of the sealers requires a larger number of laborers for mixing and placement.

Materials Required

24. The materials required include sand and the sealer. The sand is required for filling small voids and cracks and also provides a suitable skid-resistant surface

for traffic. The amount of sand used will vary with the type of sealer and other conditions as required. The storage requirements of these materials will vary with the type of material, but generally the materials should be kept in a dry location with the temperature maintained above freezing.

Recommended Construction Method

25. The construction method recommended varies with the type of sealer and the size of the area to be sealed. The following are general construction recommendations for pavement sealing:

- a. The pavement should be cleaned of all organic and loose material.
- b. Damaged pavement should be repaired prior to sealing. Newly laid asphalt pavements should be allowed to cure for several weeks prior to sealing.
- c. The use of a mechanical squeegee to apply the sealer when applicable will provide for a more uniform surface than hand squeegeeing. Where large cracks are to be sealed, they should be filled and allowed to cure completely before the first coat of sealer is applied.
- d. Clean, dry sand is added to the sealer to provide a suitable riding surface. The sand will also aid in filling any cracks and normally improves workability of the sealer.
- e. A second coat of sealer is required (except for No. 21 Epoxy) when

there are pinholes or voids left in the first coat. These pinholes or voids occur most often when a component of the sealer evaporates as it cures. A second coat also helps correct minor surface defects present in the pavement, such as small cracks and holes.

- f. Traffic should not be allowed on the sealer for a minimum of 24 hours after placement, but in no case before the sealer has achieved an initial set.

Application Rates

26. The application rates vary with the type of sealer and the condition of the pavement sealed (Tables 2 and 3). Based on the results of the test section, 0.15 to 0.20 gal per sq yd should be applied in the first layer and 0.10 to 0.15 gal per sq yd should be applied in the second layer.

PART IV: ECONOMICS

27. Fact sheets concerning each sealer product are given in Appendix A. These fact sheets contain the supplier's name, product description, suggested preparation, application rates, and material cost for the fuel-resistant sealer demonstrations. Product costs will vary with the cost per gallon decreasing as the quantity purchased in-

creases. The material costs for the test sections at Ft. Rucker and Ft. Belvoir are shown in Table 4. Another factor affecting cost is the shipping cost, which is governed by the distance from the construction site to the point of shipping. Application costs for the sealers are approximately equal.

PART V: ADVANTAGES/DISADVANTAGES

28. As previously mentioned in this report, preventing the intrusion of fuel into asphalt pavements will significantly extend the useful life of pavements. Use of fuel-resistant sealers will result in increased pavement life and lower maintenance costs.

29. Several of the materials used are flammable, and most are skin irritants. However, after their initial cure or set, they should provide an environmentally acceptable product.

30. All of the products are affected by climatic conditions. They all cure faster at higher temperatures. The rate of cure can be partially controlled by adding additional thinners where possible. No. 21 Epoxy cannot be thinned (this product can be purchased with a lower viscosity) to allow a longer working time before setting up. Super Seal and AEX-1480, both thinned by water, can be placed on damp (nonponded) pavement.

PART VI: SUMMARY

31. The application of five fuel-resistant pavement sealers was demonstrated at Ft. Rucker, Ala., and Ft. Belvoir, Va. An acceptable method of application, including materials and labor, for fuel-resistant pavement sealers was demonstrated. A video

cassette covering all phases of construction was prepared for future use. The advantages and disadvantages of each of the five products, including cost, were presented. Follow-up investigations of the fuel-resistant sealers are presented in Appendix B.

Table 1
Fuel-Resistant Sealers Used in Demonstrations

<i>Product Name</i>	<i>Manufacturer</i>	<i>Type of Sealer</i>
AEX-1480	Adhesive Engineering Co. San Carlos, Calif.	Resin epoxy
No. 21 Epoxy	American Protective Coating Corp. Cleveland, Ohio	Coal tar epoxy
Super Seal	Koppers Co., Inc. Monroeville, Pa.	Coal tar emulsion with rubber
R-526B and R-607	Rub-R-Road, Inc. Akron, Ohio	Rubberized sealant
M-6249	Uniroyal, Inc. Mishewaka, Iowa	Nitrile rubber adhesive

Table 2
Ft. Rucker Demonstration

<i>Material</i>	<i>Layer</i>	<i>Sand Content*</i> <i>lb per sq yd</i>	<i>Application Rate**</i> <i>gal per sq yd</i>
AEX-1480	1	0.9	0.17
	2	0.7	0.15
No. 21 Epoxy	1	0.9	0.16
	2	0.6	0.14
Super Seal	1	1.2	0.18
	2	1.0-2.2†	0.14
R-526B and R-607	1	0.9	0.13
	2	0.7	0.11
M-6249	1	1.1	0.18
	2	1.0	0.14

* Sand content, except for Super Seal and to a lesser extent M-6249, is limited by the sealer's ability to hold sand in suspension.

** Application rates for the first layer are generally higher due to sealer absorption and pavement defects (filling in cracks, etc.).

† The larger amount of sand was added to part of one pad. It mixed and applied well, and even more could have been added.

Table 3
Ft. Belvoir Demonstration

<i>Material</i>	<i>Layer</i>	<i>Sand Content*</i> <i>lb per sq yd</i>	<i>Application Rate**</i> <i>gal per sq yd</i>
AEX-1480	1	None	0.15
	2	0.8	0.13
No. 21 Epoxy	1†	1.0	0.12
Super Seal	1	None	0.18
	2	1.5	0.13
R-526B and R-607	1	None	0.15
	2	0.9	0.12
M-6249	1	None	0.18
	2	1.0	0.16

* Sand was not applied in the first layer except for No. 21 Epoxy. Sand content, except for Super Seal and to a lesser extent M-6249, is limited by the sealer's ability to hold sand in suspension.

** Application rates for the first layer are generally higher due to sealer absorption and pavement defects (filling in cracks, etc.).

† No. 21 Epoxy was placed in one layer only.

Table 4
Material Cost of Sealer per Square Yard

<i>Material</i>	<i>Ft. Rucker</i> <i>Cost per</i> <i>sq yd</i>	<i>Ft. Belvoir</i> <i>Cost per</i> <i>sq yd</i>
AEX-1480	\$10.88	\$9.52
No. 21 Epoxy	\$ 5.97	\$2.39
Super Seal	\$ 0.46	\$0.45
R-526B and R-607	\$ 3.95	\$4.44
M-6249	\$ 4.78	\$5.08

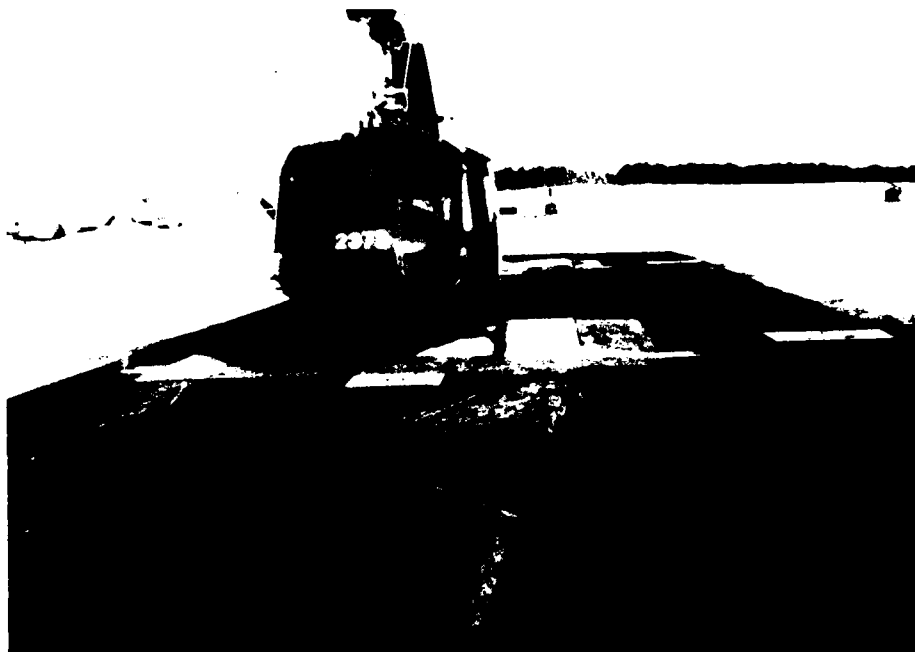


Photo 1. Concrete helipad and surrounding asphalt pavement at Ft. Rucker, Ala.

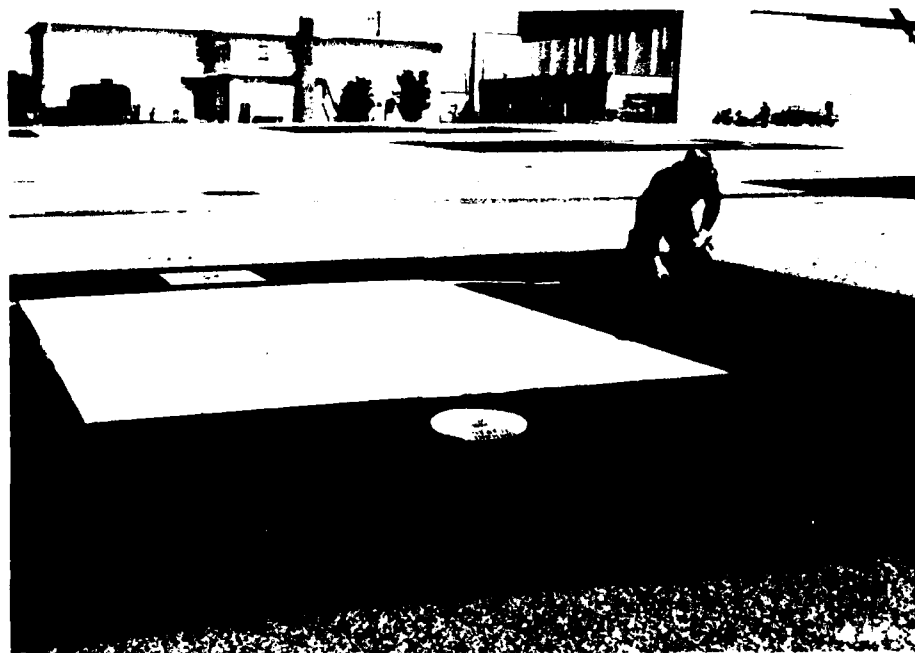


Photo 2. Cleaning with compressed air



Photo 3. Asphalt pavement damage from fuel spillage



**Photo 4. Premixing or stirring a
sealer in its original container**

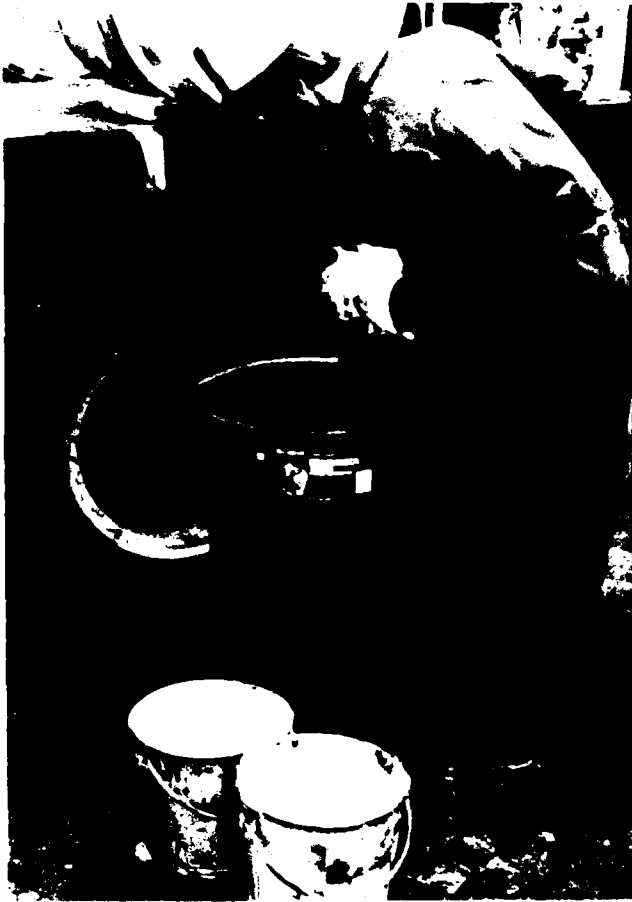


Photo 5. Plastic garbage can used for mixing sealers

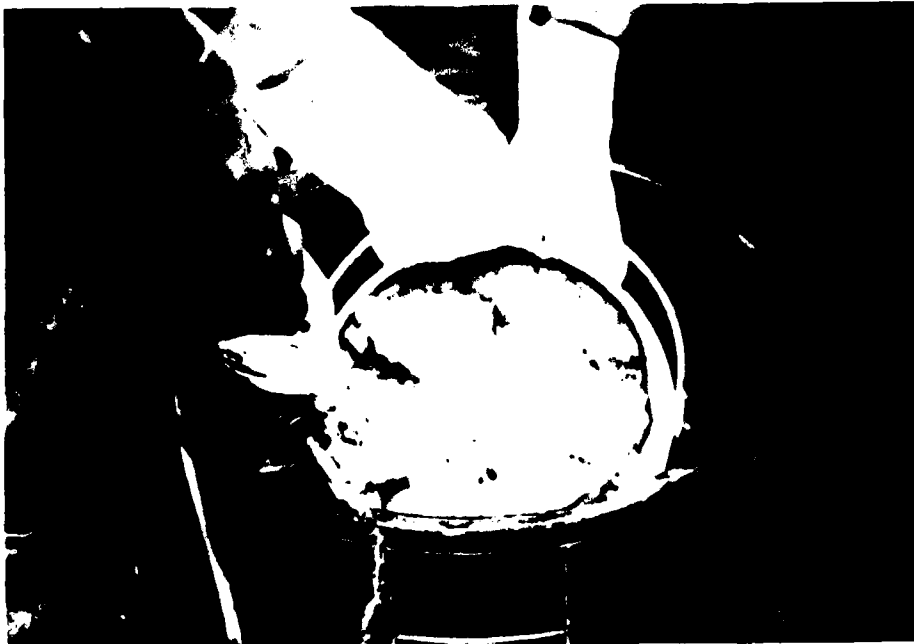


Photo 6. Adding and stirring concrete sand with a sealer



Photo 7. Galvanized steel buckets used to measure and transport sealer components



Photo 8. One-half-inch electric drill with metal stirring attachments



Photo 9. Applying sealer around a concrete helipad



Photo 10. Nearly completed sealed helipad



Photo 11. A C-12 aircraft parked on the apron at Davison Airfield



Photo 12. Removing fuel-damaged pavement prior to patching

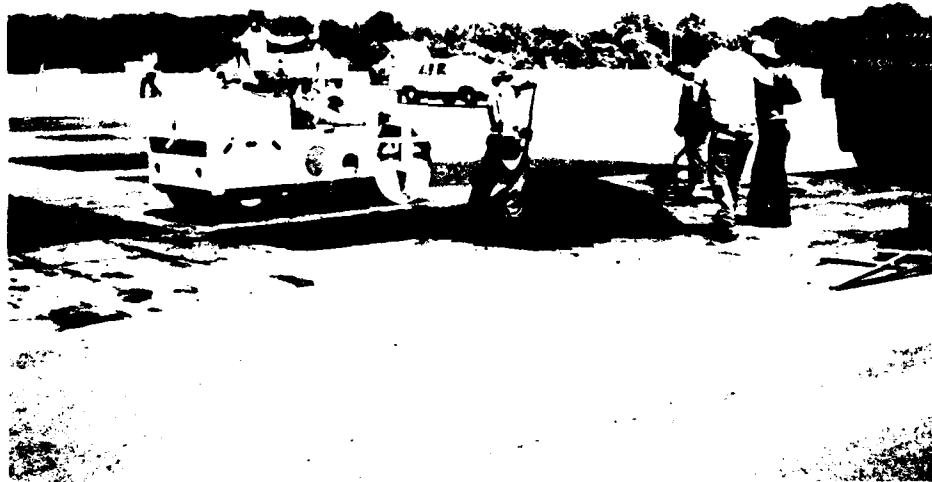


Photo 13. Patching fuel-damaged areas

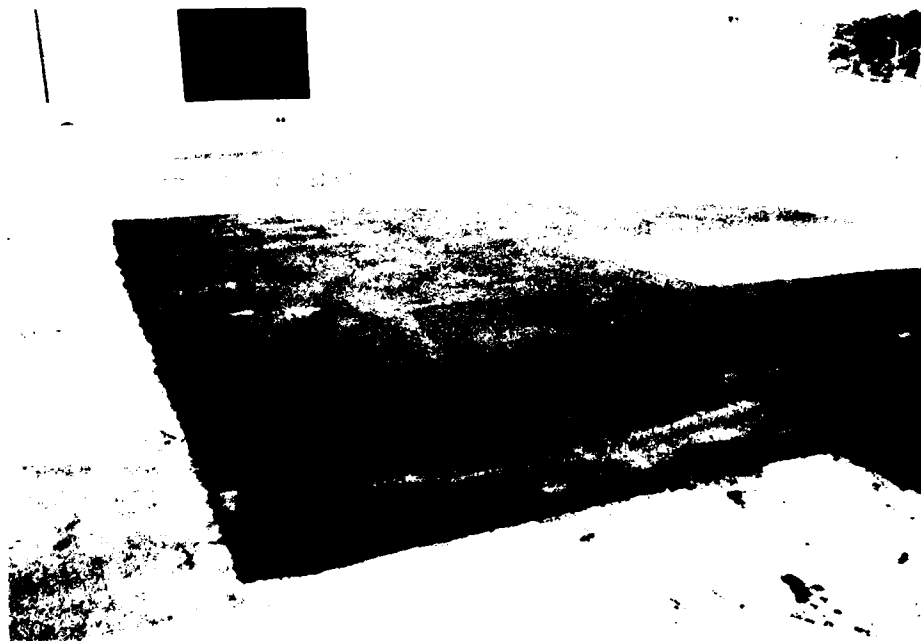


Photo 14. Patched areas on the parking apron before sealing

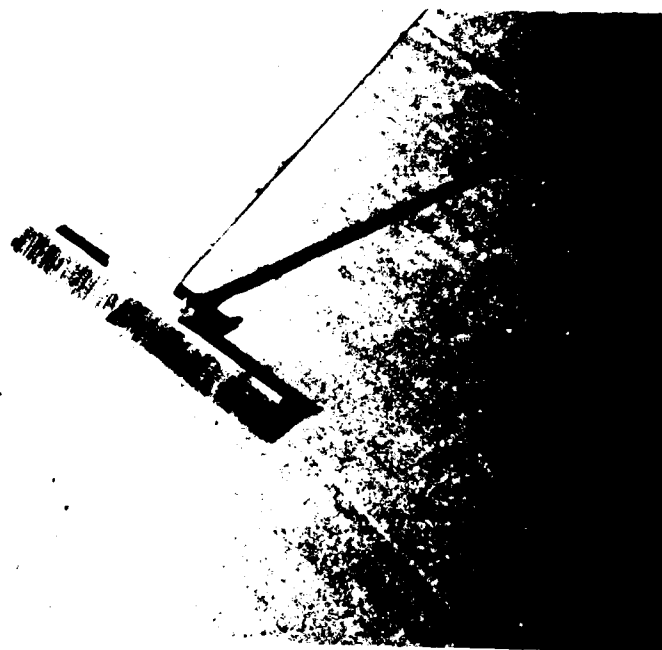


Photo 15. Wire bristle squeegee



Photo 16. Apron area, lower right, before sealing with No. 21 Epoxy



Photo 17. Applying No. 21 Epoxy

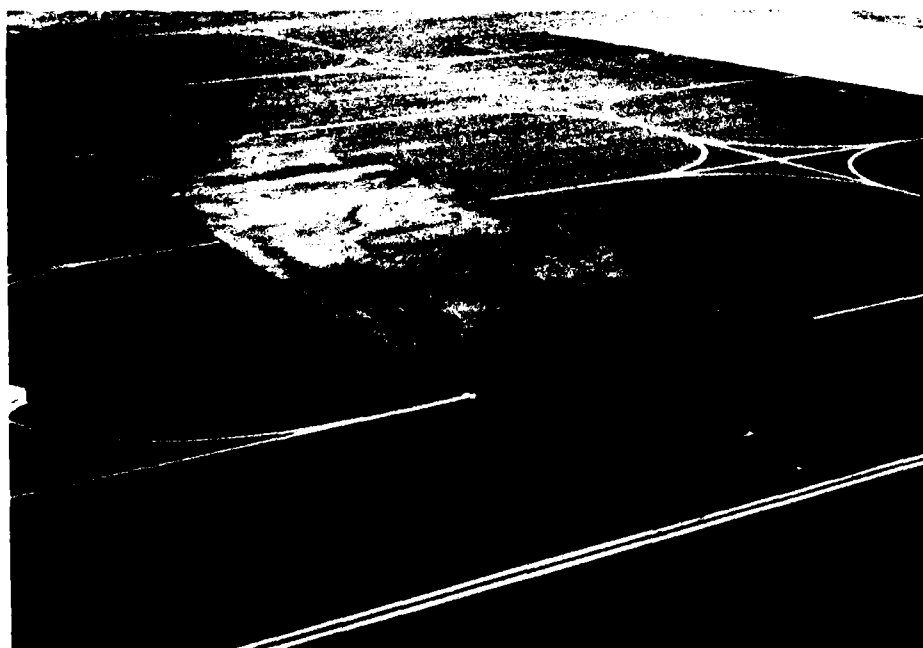


Photo 18. Parking apron after sealing with No. 21 Epoxy

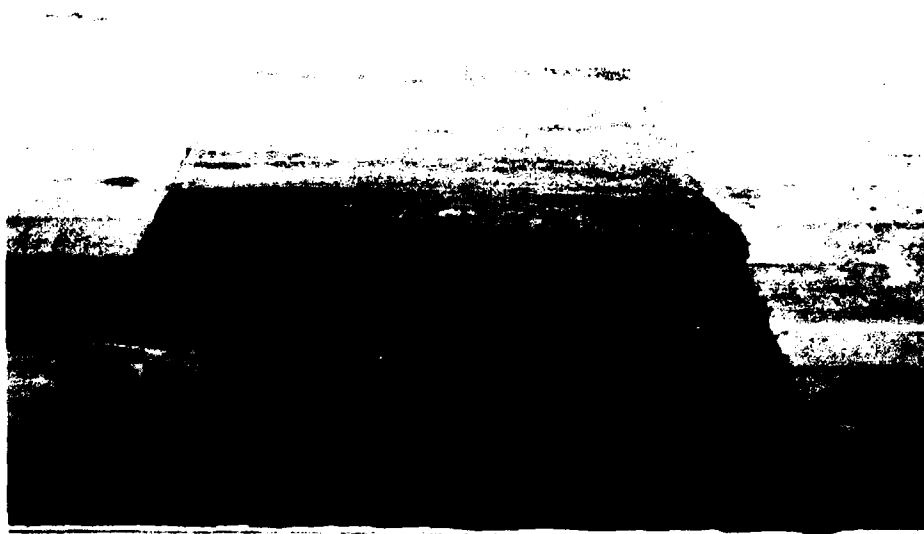


Photo 19. Four sealed parking areas. From front to back the sealers are (1) Super Seal, (2) Rub-R-Road, (3) AEX-1480, and (4) M-6249

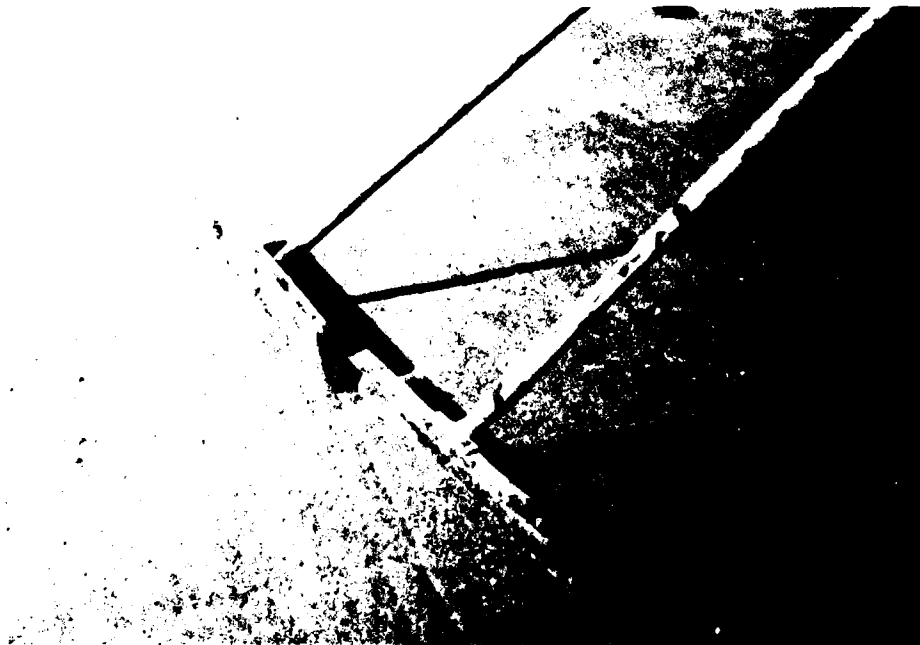


Photo 20. The two types of squeegees used to apply sealers—wooden-braced on the left and metal-braced on the right

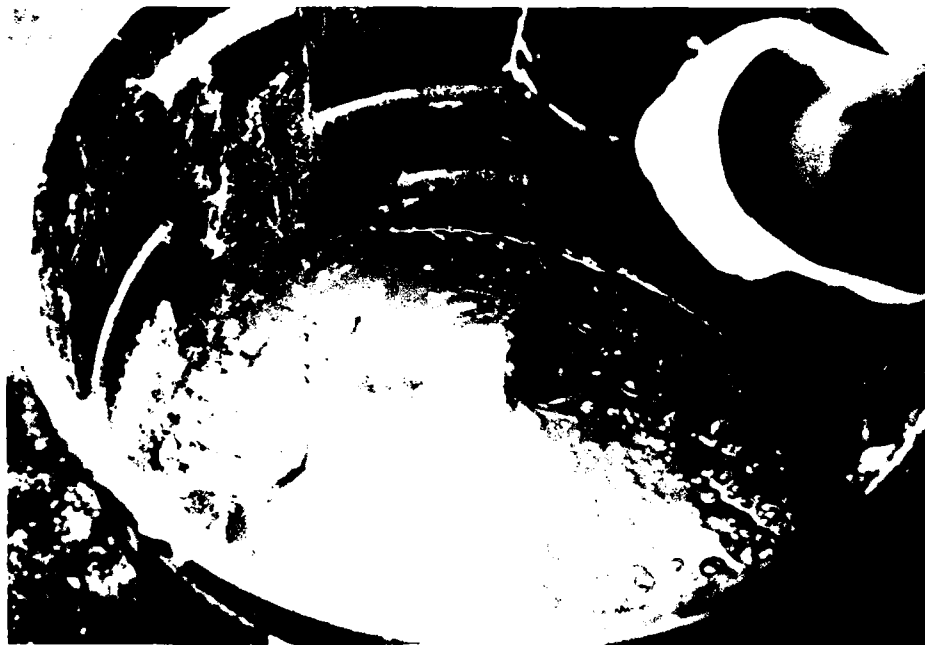


Photo 21. Sand being mixed in with a sealer



Photo 22. Applying sealer with squeegees

APPENDIX A: FACT SHEETS

AEX-1480

Supplier: Adhesive Engineering Company
1411 Industrial Road
San Carlos, CA 94070
(415) 592-7900

Contacts: Messrs. J. D. Donald and Frank Finch

Description: Concrese AEX-1480 is a two-component water-soluble epoxy resin.

Preparation: As directed by producer, material was mixed 1 part A to 5 parts B (by weight) in the laboratory and 1 part A to 4 parts B (by volume) in the field. Material can be thinned with water when necessary.

Application Rate: 0.2 gal per sq yd

Cost: FTAT project - \$34.00/gal (200-300 gal), FOB Vicksburg, MS

General: AEX-1480 is a two-component water-soluble epoxy resin manufactured as a fuel-resistant sealer. This material cures to a light brownish color.

★ ★ ★ ★ ★

No. 21 Epoxy

Supplier: American Protective Coatings Corporation
American Building
11350 Brook Park Road
Cleveland, OH 44130
(216) 676-9500

Contact: Mr. Earl Melchior

Description: No. 21 Epoxy is a coal tar epoxy.

Preparation: Combine 1 part binder to 1 part activator.

Application Rate: 0.1 gal per sq yd

Cost: FTAT project - \$19.90/gal, FOB Cleveland, OH

General: No. 21 epoxy is manufactured as a fuel-resistant pavement sealer. This material is black.

★ ★ ★ ★ ★

Super Seal

Supplier: Koppers Co., Inc.
440 College Park Drive
Monroeville, PA 15219
(412) 227-2295/(614) 522-3131

Contacts: Messrs. Mike Carvlin, Mike Dvorchak, and Dave Harriot

Description: Super Seal is a rubberized coal tar emulsion.

Preparation: Dilute with water as required.

Application Rate: 0.2 to 0.3 gal per sq yd

Cost: FTAT project - \$1.45/gal, FOB Garwood, NJ

General: This coal tar emulsion and similar emulsions have been used for several years to seal pavements and protect them from the damaging effects of fuel spills. This product containing coal tar cures to a black color.

★ ★ ★ ★ ★

Rub-R-Road (R-526B plus R-607)

Supplier: Rub-R-Road, Inc.
1206 North Main Street
Akron, OH 44720
(216) 499-2900

Contact: Mr. Pat Welsh

Description: Rub-R-Road is a rubberized sealant (R-526B).

Preparation: 3 parts of R-526B to 1 part R-607

Application Rate: 0.2 gal per sq yd

Cost: FTAT project - \$16.44/gal (55-gal drum), FOB Vicksburg, MS

General: R-526B and R-607 are manufactured as a pavement sealing compound. These components are extremely flammable. This material is available in a variety of colors; the R-526B component is black.

★ ★ ★ ★ ★

Royal M-6249

Supplier: Uniroyal, Inc.
312 N. Hill Street
Mishewaka, IN 46544
(219) 255-2181

Contact: Mr. Bill Harrington

Description: M-6249 is a rubberized adhesive which can be thinned with acetone or methyl ethyl ketone (MEK).

Preparation: 2 parts adhesive to 1 part thinner (acetone)

Application Rate: 0.2 gal per sq yd

Cost: FTAT project - \$14.93/gal (55-gal drum), FOB Vicksburg, MS

General: This material is manufactured as an adhesive for applications that are subject to exposure to various types of aviation fuel. This material is brown and extremely flammable.

APPENDIX B: INSPECTION OF FUEL-RESISTANT SEALERS AT FT. RUCKER, ALA., AND FT. BELVOIR, VA.

November 1985 Inspections

1. The fuel-resistant sealers which had been placed in the summer of 1984 as part of the FTAT were inspected in November 1985. The sealers included AEX-1480, Super Seal, Rub-R-Road (R-526B plus R-607), No. 21 Epoxy, and M6249.

Ft. Rucker, Ala.

2. The AEX-1480 was placed around a helicopter pad which had not been used and thus had not been subjected to fuel spillage. In some places cracks in the asphalt concrete had been effectively sealed. The material had remained slightly flexible. In some places there was much more sand than in other areas, indicating segregation of the mixture during application. The overall condition of the material was good.

3. The Super Seal was placed in an area that had been subjected to fuel spillage. Much closely spaced block cracking had occurred and apparently the cracks only penetrated the sealers and did not exist in the asphalt concrete. The material was brittle, which probably indicates that more deterioration would occur. The overall condition of this sealer was fair to poor.

4. The Rub-R-Road sealer was placed in an area that had been subjected to fuel spillage. No cracks had occurred in the sealer except for cracks reflecting from the underlying asphalt concrete. The material had remained flexible. It was in very good condition.

5. The No. 21 Epoxy sealer was placed in an area that had been subjected to fuel spillage. Much cracking had occurred in the sealer and the material had ravelled back

from the cracks. The sealer had pulled the asphalt concrete up in spots. The sealer had become brittle and curling of the sealer adjacent to cracks had occurred. According to personnel at Ft. Rucker, the problem began with large bubbles in the sealer. This test item was in a failed condition.

6. The M-6249 sealer was placed in an area that had been subjected to fuel spillage. The material was flexible, having properties similar in appearance to polypropylene. No cracking had occurred except for cracks reflecting from the underlying asphalt concrete. This material did a good job of sealing cracks. It was obvious that the material was not evenly spread over the surface during construction. According to personnel involved in placing the material, it was sticky and stringy when placed, making it difficult to spread evenly. The overall condition of this material was good except for the appearance which was caused by the placement problems.

Ft. Belvoir, Va.

7. The AEX-1480 had become brittle but did show good bond to the underlying asphalt concrete. Much surface cracking had occurred, probably as a result of the material becoming brittle. Some cracks existed in the asphalt concrete prior to being sealed and these cracks reflected through the sealer. The overall condition of this section was fair to good.

8. Some of the Super Seal had been eroded from the surface at the time of inspection. This might have been caused by moisture in the asphalt concrete at the time it was sealed. This material had become brittle and did show some hairline cracking,

which is indicative of a brittle material. The overall condition of this sealer at the time of inspection was fair.

9. The Rub-R-Road sealer was flexible and appeared to be well bonded to the underlying asphalt concrete. The sealer did a good job of sealing existing cracks and no surface cracking had developed. In five to six isolated places the sealer material appeared to be scraped from the surface. The size of each of these isolated areas was approximately 1 sq ft. The overall condition of this test section at the time of inspection was good.

10. No. 21 Epoxy was placed over some good asphalt concrete and some which had failed. Obviously, the material placed over the failed asphalt concrete did not perform very well. The material placed in the good area was carefully inspected. The material did provide a good bond and the amount of cracking was small. A crack was observed in the asphalt concrete around the outside of the treated area. This crack is likely the result of different thermal expansion and shrinkage characteristics between the asphalt concrete and the sealer. In investigating the section, it appeared that thicker applications had hairline cracks, but thinner applications did not crack. The material bonded very well to the asphalt concrete and appeared to be hard and brittle. The overall condition of this treated area was good.

11. The M-6249 material, which had remained flexible, had performed satisfactorily in sealing cracks existing in the asphalt concrete. The bond to the underlying asphalt concrete was very good and no cracking had occurred in the sealer material. Some slight surface damage had occurred in localized areas where the sealer material had been scraped from the surface. This had occurred in three to four locations, with each location having an area of approximately 1 sq ft. The overall performance of this material was excellent.

Results of Inspections

12. After inspection of the materials at Ft. Rucker and Ft. Belvoir, differences in the performance of the materials was obvious. Rub-R-Road and M-6249 had remained flexible at both locations. These materials were performing better than the other three materials which had become brittle and had shown signs of cracking and other problems. The softer materials did show more distress caused by the abrasive effects of traffic, but the overall performance of Rub-R-Road and M-6249 was better than the performance of the stiffer materials.

May 1986 Inspections

13. A final inspection of the fuel-resistant sealers placed under the FTAT program was made on 20 May 1986 by a panel of Department of Defense engineers. The investigation included five materials at Ft. Belvoir and five at Ft. Rucker.

14. During this inspection, the sections treated with sealer were evaluated for cracking, scuffing or wear, fuel damage, delamination, and overall appearance. After evaluation of these test sections in each of these categories, the materials were rated by the panel as acceptable or unacceptable for use as fuel-resistant sealers.

Ft. Rucker, Ala.

15. All of the treated areas had been covered with another fuel-resistant sealer, MU-MIX, approximately 3 months prior to this inspection. A contract had been awarded to seal all helicopter pads in this area which included approximately 10 pads which had been sealed with the five fuel-resistant sealers in the FTAT study.

16. The new sealer did not cover the entire area that had been sealed under FTAT. Each test area had a small amount of material that extended outside the new

treated areas. There was no reason to believe that the performance of the sealer had changed since the inspection in November 1985.

Ft. Belvoir, Va.

17. No. 21 Epoxy experienced a large amount of cracking. There were a few isolated areas of poor pavement that had been covered with No. 21 Epoxy, and obviously these bad areas reflected through the sealer. Most of the section was satisfactory prior to being sealed, but even in these areas, cracking had occurred in the sealer. It appears that the cracks had widened with time due to the sealer breaking off adjacent to the cracks. Many of the cracks were as much as 1/2 in. wide. There was a crack most of the way around the boundary of the test section. In one area it appeared that material had been placed in one direction while adjacent material was placed at right angles to the first material applied. A crack had occurred at the intersection of these two sections. It is not known whether the crack occurred due to direction of placement or due to the difference in amount of material applied in each of the two directions. It is believed that the crack was caused by differences in the amount of material applied. No scuffing or wear had occurred in the test section. There was a small amount of fuel damage adjacent to some of the cracks where fuel came in contact with the underlying asphalt concrete. There was no fuel damage in other areas. No. 21 Epoxy bonds very well to the underlying area, and there was no noticeable delamination. The overall appearance was good except for the cracks which had occurred.

18. Super Seal experienced a large amount of hairline cracking. The cracks were not wide, but surface crazing could be seen throughout the section. There was some wear or scuffing in a few isolated areas

which seemed to be caused by snow removal equipment. There appeared to be no fuel damage; however, the section did not appear to be fuel resistant in the isolated spots where material had been bladed off or eroded from the surface. One small area did show possible delamination between the tar sealer and asphalt concrete. The cause of this delamination is not known; however, the asphalt concrete surface in this area could have been damp during placement of the sealer which would have prevented development of a satisfactory bond. Overall appearance of this section was fair.

19. The Rub-R-Road experienced very little cracking. The small amount of cracking which had occurred was hairline. A small amount of wear or scuffing which was probably caused by snow removal equipment was observed. Fuel damage had not occurred on this section and there was no delamination of materials. The overall appearance of this material was very good.

20. AEX-1480 experienced a large amount of hairline cracking. A small amount of wear or scuffing had occurred which was apparently caused by snow removal equipment. Fuel damage was not observed on this section. There was no delamination between the sealer and the asphalt concrete. The sealer is light colored which caused the hairline cracks to be highly visible. The overall appearance of this section was fair.

21. M-6249 had experienced no cracking except for a few small cracks that had reflected from the underlying material. Some of the cracks in the underlying material had been effectively sealed. Some wear or scuffing had occurred, again apparently caused by snow removal equipment. Fuel damage had not occurred, and there was no delamination between the sealer and asphalt concrete. The surface texture was not consistent, indicating some difficulty in placing the material. The overall

appearance was good; however, the rust color and inconsistent surface texture detracted from the appearance.

Conclusions and Recommendations Based on Inspections

22. Based on the two site visits to Ft. Belvoir and the two to Ft. Rucker, the following conclusions and recommendations were made:

- a. No. 21 Epoxy should not be used as a fuel-resistant sealer. It tends to crack and deteriorate adjacent to the crack. When this sealer is placed over poor quality asphalt concrete, it can destroy the surface of the asphalt concrete.
- b. Super Seal should be allowed for use as a fuel-resistant sealer. It does develop hairline cracks and wear from the surface; however, it is relatively inexpensive. To be used successfully, it must be used to periodically reseal the asphalt concrete. Treated areas should be resealed after 1-2 years.
- c. Rub-R-Road should be allowed for use as a fuel-resistant sealer. It does

effectively seal the surface and does not readily crack. Because of the flexibility, it may wear quickly under traffic with very high tire pressure or tracked wheel traffic. Treated areas should be resealed after 3 to 4 years.

- d. AEX-1480 should not be used as a fuel-resistant sealer. It tends to develop a large amount of hairline cracks. Its performance is similar to coal tar but it is much more expensive.
- e. M-6249 should be allowed for use as a fuel-resistant sealer. It does effectively seal the surface and does not readily crack. Because of the flexibility, it may wear quickly under traffic with very high tire pressure or tracked-wheeled vehicles. Some operations personnel dislike this material because of the rust color. Treated areas should be resealed after 3 to 4 years.
- f. The overall ratings of the test sections were as follows:

M-6249	good
Rub-R-Road	good
Super Seal	fair
AEX-1480	fair
No. 21 Epoxy	poor

END

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